

# Coated conductors at Los Alamos – Progress and Projections

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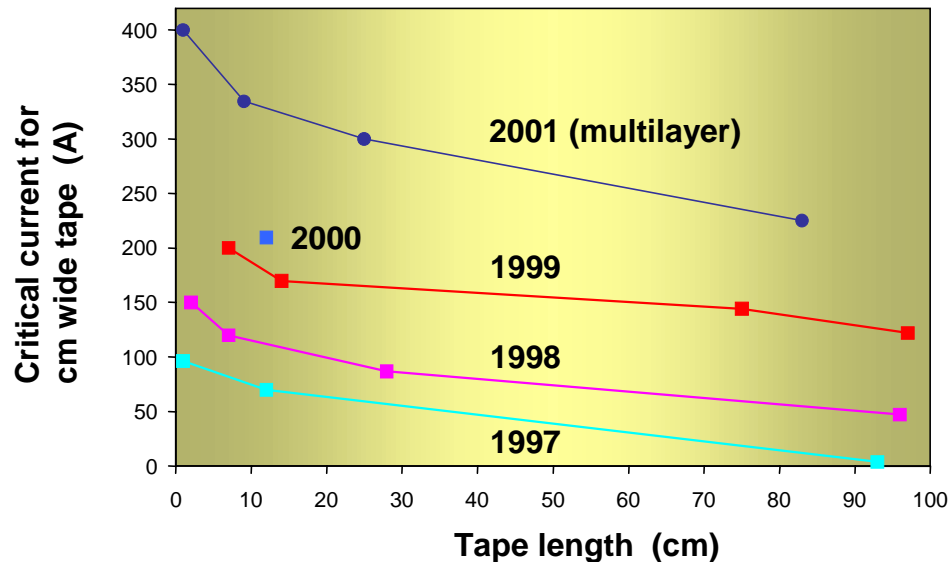
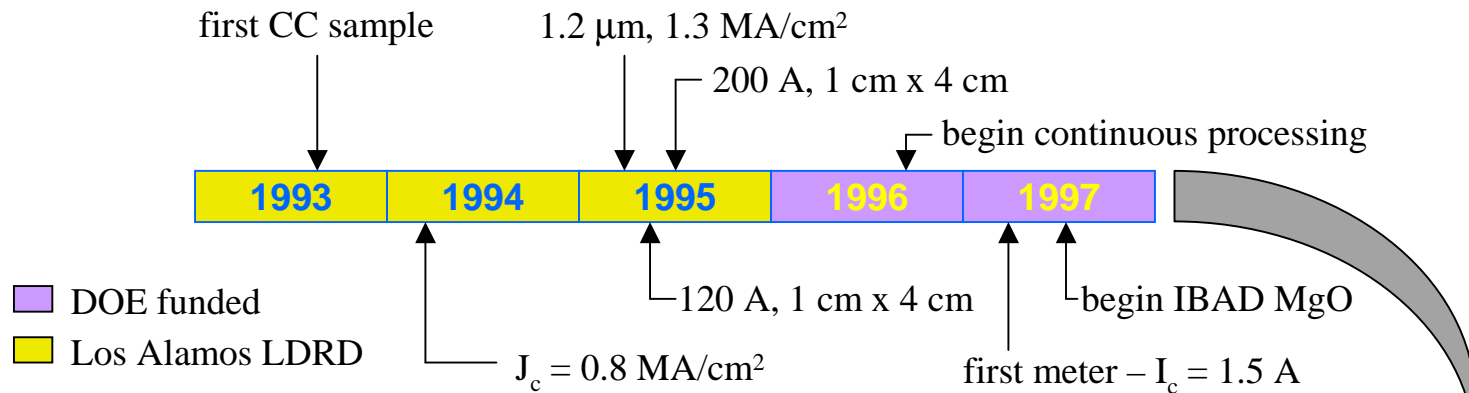
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# Coated conductor milestones for IBAD/PLD at Los Alamos



## The future of coated conductors at Los Alamos

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	2002	2003	2005
Conductor Performance	$I_c = 250$ A 1 cm x 1 m		$I_c = 1000$ A two-sided meter
Cost Reduction	50 A meter IBAD MgO	YBCO on IBAD MgO as good as on IBAD YSZ	Reduce PLD cost by 5x from 2001 level
Research Park	Reel-to-reel process operational	10 meters $I_c = 50$ A IBAD MgO	100 meters $I_c = 100$ A IBAD MgO

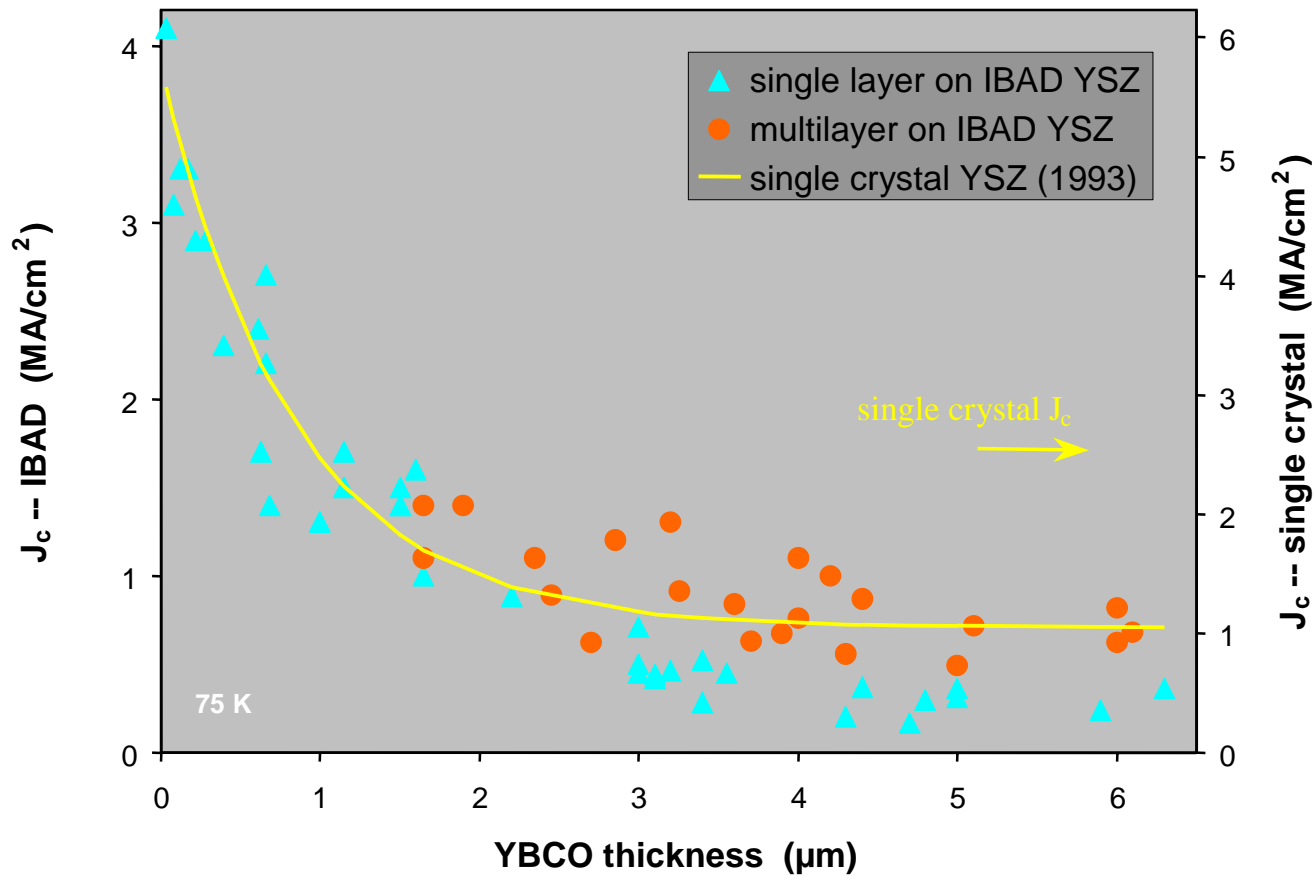
# Obstacles to reaching conductor performance goals

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- ❖ Rapid drop in  $J_c$  with increasing YBCO thickness
- ❖ No scientific understanding of how multilayers work
- ❖  $I_c$  nonuniformity in continuously-processed tapes

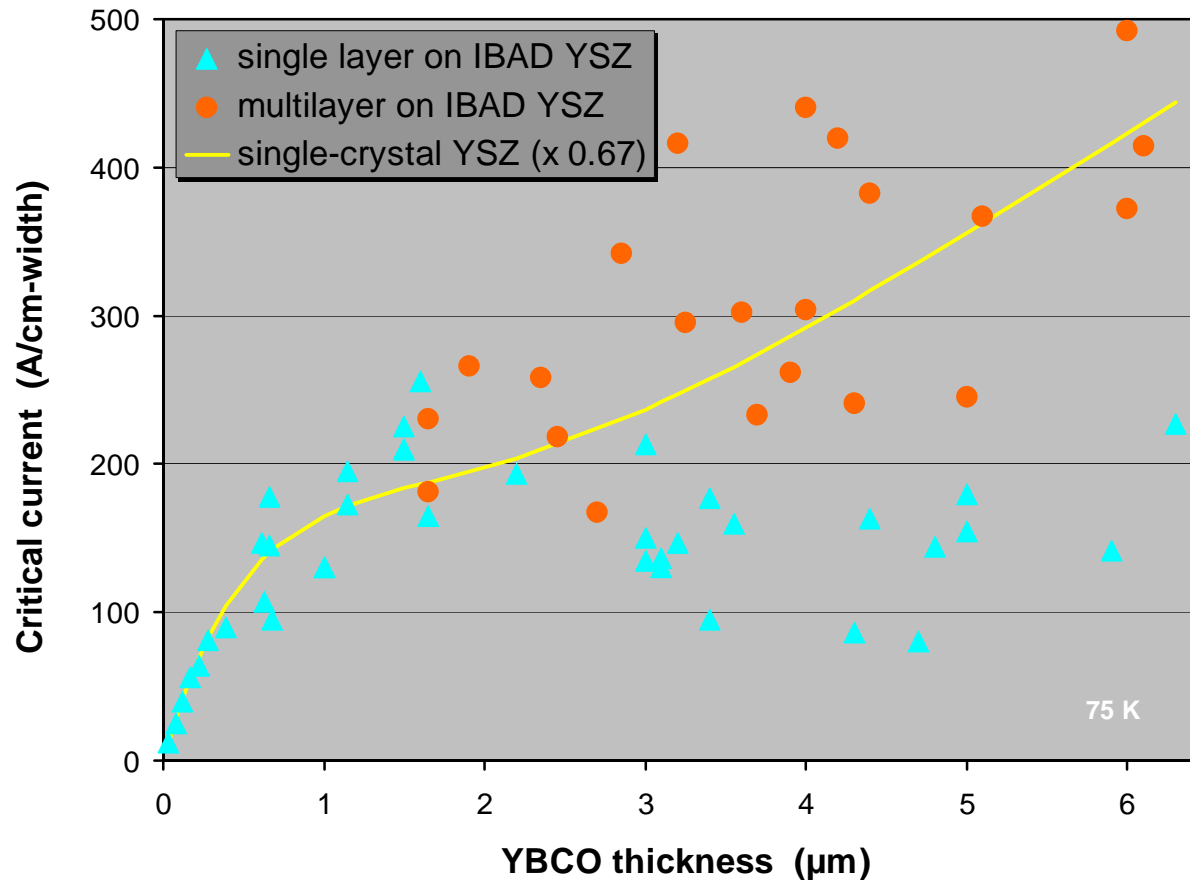
# High current requires thick films (I)

YBCO/Sm-123 multilayers help for thickness  $> 2 \mu\text{m}$ , but do not solve the basic problem



## High current requires thick films (II)

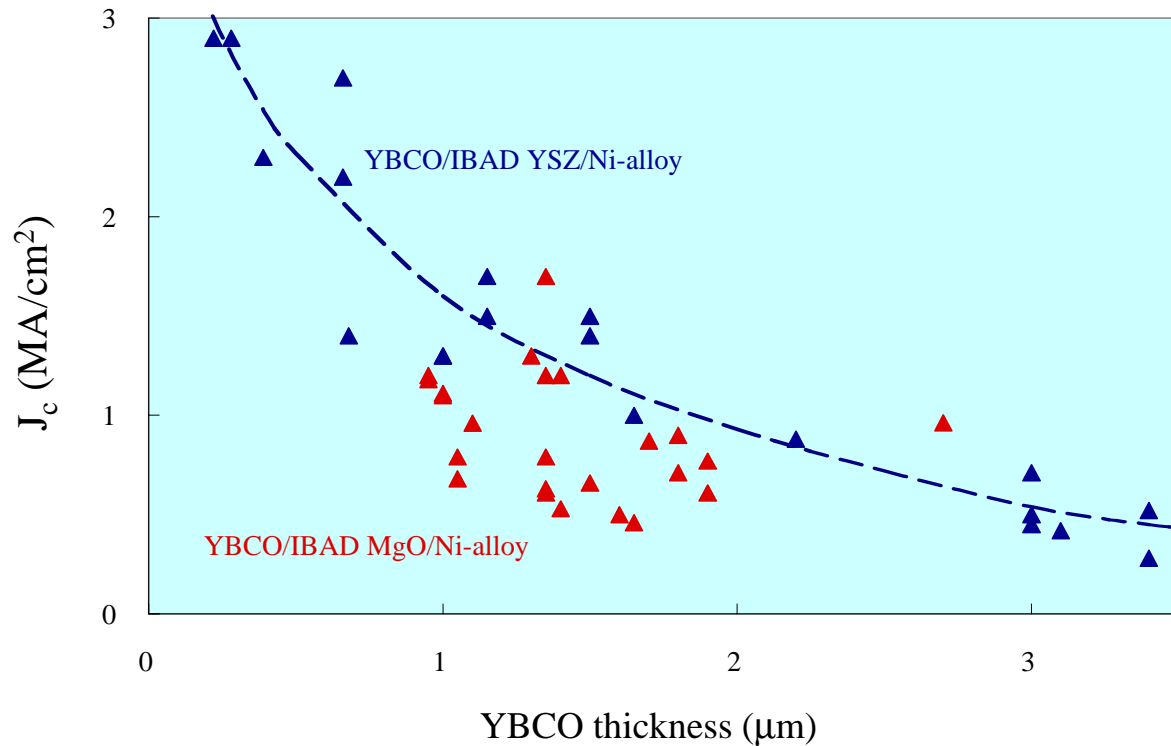
- $I_c$  for 200  $\mu\text{m}$  bridges scaled to 1 cm width
- Single crystal  $I_c$ s multiplied by 0.67



# IBAD MgO obstacles to achieving 2005 coated conductor projections

## Performance limitations vs. IBAD YSZ not well understood

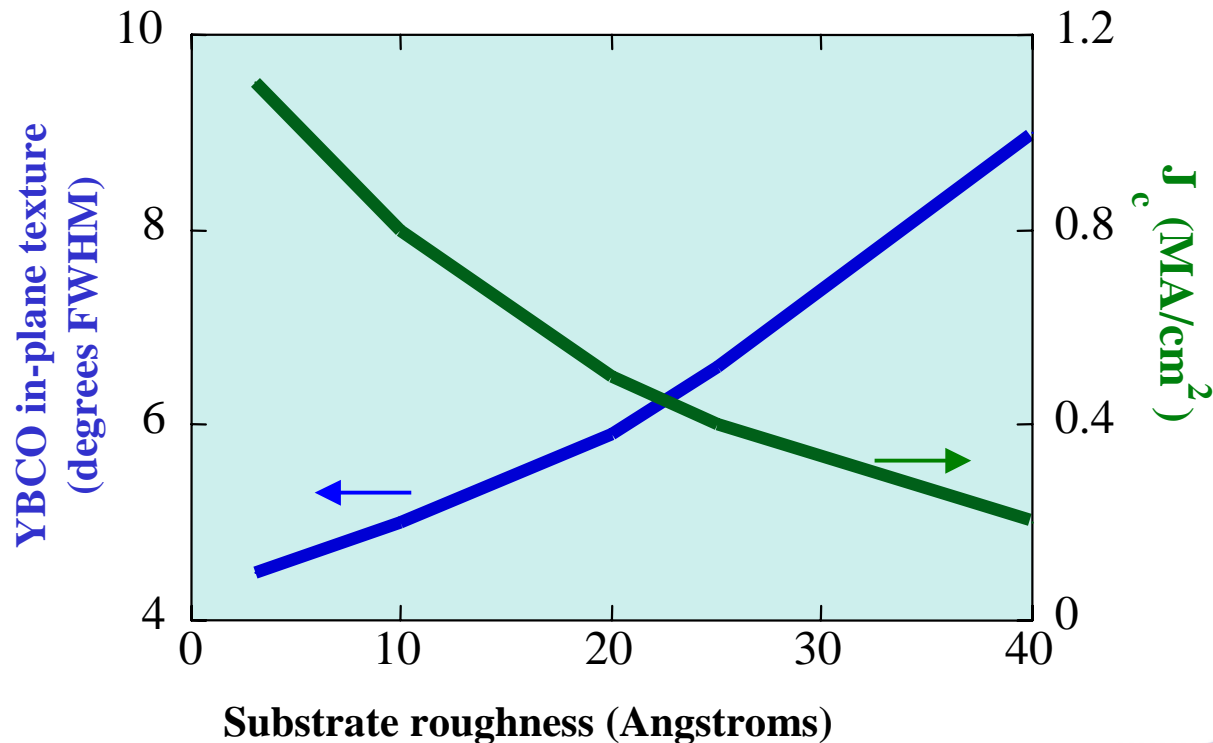
- Intrinsic to template micro & macro structure differences?
- Will different buffer materials improve YBCO performance on IBAD MgO?



# IBAD MgO obstacles to achieving 2005 coated conductor projections (cont.)

## Thinner IBAD demands a smoother substrate platform

Fabrication/finishing methods must be easily implemented and cost effective (e.g. as-rolled, electropolishing, CMP).

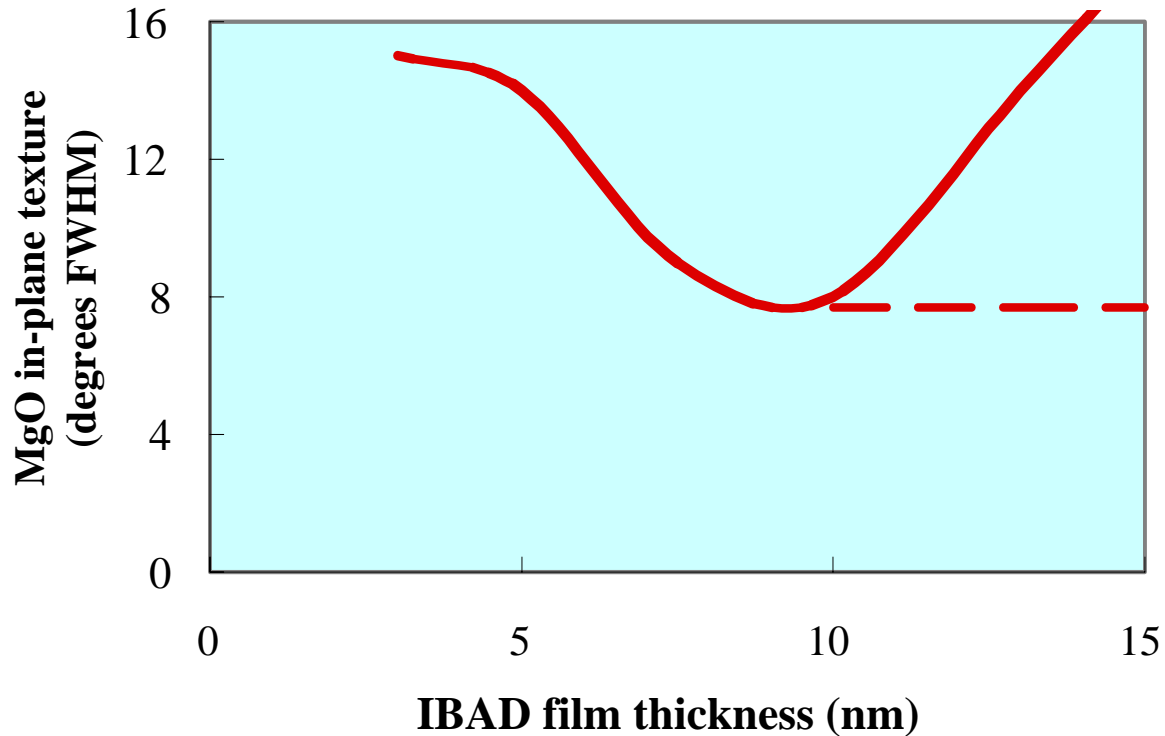




# IBAD MgO obstacles to achieving 2005 coated conductor projections (cont.)

## IBAD MgO has a narrow processing window

Can method(s) to increase IBAD thickness limitation also ameliorate platform smoothness requirements?



# Challenges to reaching 2005 Research Park projections

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- New knowledge is required for longer lengths
  - Need to address new issues, e.g. tape handling, quality control metrics, etc. (“longer is different”)
- Process control -- zero tolerance of “killer” defects
  - Need an understanding of process windows for all variables in each step: metal substrate (e.g. roughness control), IBAD (e.g. texture control), PLD (e.g. superconductor properties)
  - Need in-line quality control, especially upstream and *in-situ*
- Adequate resources
  - Stable funding
  - Qualified manpower

# Los Alamos involvement in coated conductor CRADAs

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- ASC (1996 - 2001) – sample exchange and analysis
- 3M (1997 - present) – IBAD modeling and *in-situ* monitoring, sample exchange and analysis
- IGC (2000 - present) –technology transfer for 100 A tape

# Scaling up Coated Conductor technology at IGC-SuperPower

- 3-yr CRADA with LANL and ANL to scale up coated conductor technology to manufacturing
- Pilot-scale facilities set up for buffer and YBCO manufacturing end of CY'00.
- Coated conductor made in short lengths (up to 1 m) using continuous processes in all steps at IGC-SuperPower end of CY'01.
- Buffer tapes with uniform texture of 13 - 14° produced. Also, YBCO tapes with  $J_c > 1$  MA/cm<sup>2</sup> produced in continuous process.



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# Projections to mid-decade

- CY'02 Demonstrate performance of 100 A-m in lengths  $> 1$  m in pilot manufacturing facilities
- CY'03 Demonstrate performance of 1000 A-m in lengths  $> 10$  m in preproduction facilities
- Mid-decade Full commercial production with performance  $> 100,000$  A-m in  $> 1$  km lengths in production facilities



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# Critical issues for discussion tomorrow

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## Alternate markets

- Will DoD programs be able to bridge the gap – as they have done in other technological fields –between the pre-commercial HTS of today and the high-volume, low-cost production needed for successful commercialization?
- Are there niche markets in which \$100-1000/kA-m is acceptable?

## J<sub>c</sub> vs. thickness

- Good combination of interesting technical problem and major cost driver.